Physics 10154 - Exam #3d

Partial credit will be given provided you show all work and are solving parts of the problem correctly. Points will be deducted if you don't show your work (or if some parts are incorrect) even if you get the right answer. Clearly indicate your answer with a circle or box and remember to include correct units and significant figures.

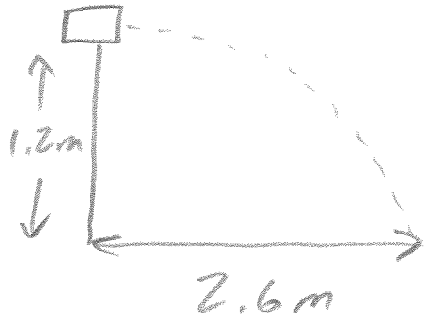
1. (30 pts) A bullet with a mass of 15 grams strikes a 440 gram block, initially at rest on the edge of a 1.2 meter high table. After the collision, the bullet is embedded in the block, and both slide horizontally off the table, landing 2.6 meters away horizontally from the bottom of the table. What was the initial speed of the bullet?

Collision

$$m_1 v_{1i} + m_2(0) = (m_1 + m_2) v_f$$

$$0.015\, v_{1i} = 0.455\, v_f$$

Ballistic motion



x	y
$\Delta x = 2.6$	$\Delta y = -1.2$
$v_{ox} = ?$	$v_{oy} = 0$
$v_x = ?$	$v_y = ?$
$a_x = 0$	$a_y = -9.8$
$t = ?$	$t = ?$

$$\Delta y = v_{oy} t + \tfrac{1}{2} a_y t^2$$

$$-1.2 = -4.9 t^2$$

$$t = 0.495\text{s}$$

$$\Delta x = v_{ox} t + \tfrac{1}{2} a_x t^2$$

$$2.6 = v_{ox}(0.495)$$

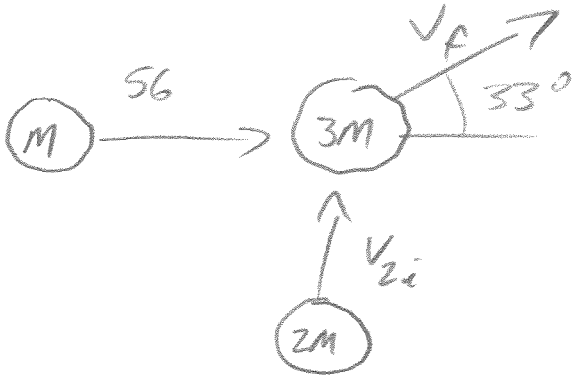
$$v_{ox} = 5.25\ \text{m/s}$$

$= v_f$ from part 1

$$0.015\, v_{1i} = (0.455)(5.25)$$

$$\boxed{v_{1i} = 160\ \text{m/s}}$$

2. (30 pts) Car A is initially moving East with a speed of 56 miles/hour. Car B, which is twice as massive as car A, is initially moving North with an known speed. After they collide, the cars stick together and the combined wreck moves off at an angle of 33° North of East. What was the initial speed of car B, in miles/hour?



$56 \frac{mi}{hr} = 25.03$

$x: \quad M(56) + 2M(0) = 3M v_f \cos 33°$

$56 = 3 v_f \cos 33° \Rightarrow v_f = 22.26 \frac{mi}{hr}$ or $9.95 \frac{m}{s}$

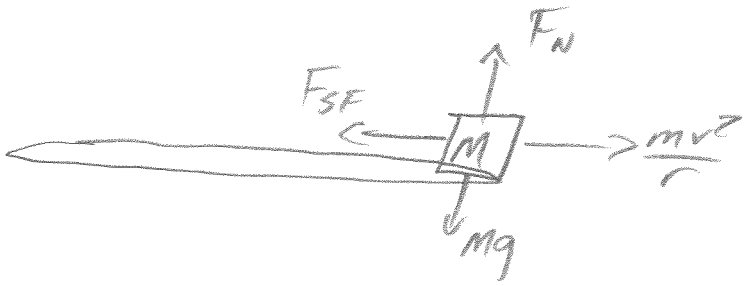
$y: \quad M(0) + 2M v_{2i} = 3M v_f \sin 33°$

$2 v_{2i} = 3(22.26) \sin 33°$

$\boxed{v_{2i} = 18 \frac{mi}{hr}}$ or $8.1 \frac{m}{s}$

3. (40 pts) A small mass sits on a turntable, 65 cm from the center, with everything initially at rest. The coefficient of static friction between the mass and the turntable is 0.75. The turntable begins to accelerate at a rate of 0.15 rad/sec^2.

How many revolutions does the turntable make before the mass begins to slide off?



Begins to slide: $F_{SF} = \mu_s F_N = \mu_s mg$ (threshold)

$$\Sigma F_{rad} = -F_{SF} + \frac{mv^2}{r} = 0$$

$$-\mu_s mg + \frac{mv^2}{r} = 0$$

$$\mu_s g = \frac{v^2}{r}$$

$$v = \sqrt{r\mu_s g}$$

$$= \sqrt{(.65)(.75)(9.8)} = 2.19 \text{ m/s}$$

$$\omega = \frac{v}{r} = 3.36 \text{ rad/s}$$

$\Delta\theta = ?$
$\omega_0 = 0$
$\omega = 3.36$ rad/s
$\alpha = 0.15$ rad/s^2
$t = ?$

$$\omega^2 = \omega_0^2 + 2\alpha\Delta\theta$$

$$(3.36)^2 = 0 + 2(.15)\Delta\theta$$

$$\Delta\theta = 37.7 \text{ rad}$$

$$= \boxed{6.0 \text{ rev}}$$